Claims

1. A method for estimating the phase in a digital communication system comprising the steps of:

- receiving and storing a block of observations Y_k;
- executing at least one phase locked loop (PLL) on a predetermined sequence of observations from said block.

2. The method for estimating the phase in a digital communication system according to claim 1 characterized by:

- executing a first phase locked loop (PLL) on said observations in order to generate a first intermediate value;
- executing a second phase locked loop (PLL) on said observations in order to generate a second intermediate value;
- combining said first and second intermediate values to generate a phase estimate.

3. The method according to claim 2 characterized in that said first loop executes on a sequence of observations according to their chronological order of occurrence, and that said second loop executes on the inverse sequence.

4. The method according to claim 3 characterized in that said second phase locked loop (PLL) is initialized to the last value calculated by said first phase locked loop.

5. The method according to claim 4 characterized in that it comprises the steps of:

- receiving and storing a block of observations Y_k, with k varying from 0 to n;

- initializing a first phase locked loop from received observations Y_k;
- executing said first phase locked loop according to the following formula:

$$\varphi_k = \varphi_{k-1} - \gamma F(Y_k, \varphi_{k-1}) \text{ with } k = 1 \text{ to } n$$

where F is a function adapted to the type of modulation considered

- initializing a second phase locked loop from observations Y_k, with k varying from n to 0;
- executing said second phase locked loop (PLL) according to the following formula:

$$\varphi'_k = \varphi'_{k+1} - \gamma F(Y_k, \varphi'_{k+1}) \text{ with } k = n-1 \text{ to } 0$$

- combining the results produced by said first and second loops to generate a phase estimate.

6. A method according to any of the preceding claims characterized in that the modulation is a binary phase shift keying (BPSK) modulation with a phase locked loop (PLL) defined by

$$\varphi_K = \varphi_{k-1} + \gamma \, \mathrm{Img}(y_k e^{-i\varphi(k-1)} \ \ \mathrm{th}[L_k / 2 + 2/\sigma^2 \mathrm{Re}(y_k e^{-I\varphi(k-1)}]\,)$$

where:

th is the hyperbolic tangent operator,
Re is the operator referring to the real part of a complex number,
σ^2 is the noise variance;
and $L_k = \mathrm{Ln}\,[\,p(a_k = 1) / p(a_k = -1)\,]$,

and Ln is the natural logarithm, p(ak =1) is the probability that symbol a_k is equal to +1 and $p(a_k = -1)$ is the probability that symbol a_k is equal to -1.

7. The method according to claim 6 characterized in that said factor γ is realized by means of a second or higher order digital filter.

8. A phase locked loop device for a digital receiver comprising:
- means to receive and store blocks of observations;
- a first phase locked loop (PLL) for generating a first intermediate value;
- a second phase locked loop (PLL) for generating a second intermediate value;
- means to derive a phase estimate form said first and second intermediate values.

9. The phase locked loop device according to claim 8 characterized in that said first and second phase locked loops are realized according to the following formula:

$$\varphi_k = \varphi_{k-1} - \gamma F (Y_k , \varphi_{k-1}) \text{ with } k = 1 \text{ to } n$$

or

$$\varphi'_k = \varphi'_{k+1} - \gamma F (Y_k , \varphi'_{k+1}) \text{ with } k = n-1 \text{ to } 0$$

where F is a function adapted to the type of modulation considered.

10. The device according to claim 9 characterized in that the first value calculated by said second loop is determined by the last calculation made by said first phase locked loop.